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SYNCHRONOUS DEMODULATOR FOR CONVERTING A TELEVISON SIGNAL INTO A VIDEO SIGNAL

The present invention relates to a synchronous demodulator for the converting a television signal furnished by an transmitter into a video signal, especially for use in a measuring chain for the analysis of a signal furnished by this transmitter in order to improve the transmission quality.

For precise measurement it is essential that the modulator does not cause distortions in the conversion process.

In order to prevent in quadrature distortion caused by signal envelope detection of the attenuated side band signal - said distortion being severe in current demodulators - it is known that in order to ensure synchronous

demodulation it suffices to use a phase-lock loop with an oscillator controlled by a reference voltage to process the restored carrier.

The commutation signal in this type of synchronous demodulator is the intermediate frequency signal is extracted from the modulated video signal, which is itself in the remaining side band, and thus dissymmetric.

After processing, the restored carrier may be in an incorrect phase and even be in opposition to the phase with the signal to be demodulated.

In order to guarantee the quality of the restored video by a synchronous demodulator, it is necessary to provide measuring means and to maintain the exactitude of the carrier phase. It is also necessary for the controlled oscillator to have a wide synchronization range in order to accommodate shifting and aging of the circuits, but also to generate only minimal phase noises which would also produce distortions on the demodulated video signal and cause serious errors in measurement.

In a prior art embodiment, in order to restore the image carrier, modulation of the amplitude is suppressed by a limiter, and the signal is employed to guide the controlled oscillator by installing a phase-lock loop.

However, the signal to be clipped is modulated and allocated to a vestigial band, this introduces a group propagation time error requiring additional correction means. Moreover, undesirable modulation appears in

the limited signal and also requires separate correction means, which complicate the installation.

In fact, everything proceeds as if the modulation range had been increased.

Another known solution is to use sampling means for delivering the reference data only if the image signal stage is considered not to vary in phase. However, if this solution has the advantage of a phase reference which is in principle correct, on the one hand, it has the drawback, of being very complex and thus unreliable and, on the other hand, of being exposed to the risk of the controlled oscillator's drifting after a discharge from the charged capacitor when the sample is taken, with the voltage being used to monitor the controlled oscillator between two samples.

The object of the invention is to provide a demodulator in which the extraction of the error signal is obtained without processing the incident signal, as a result of which errors are being prevented from being introduced into the useful video signal.

The solution to the problem is solved by a synchronous demodulator which is characterized in that:

The incident signal penetrates into said synchronous demodulation circuit by passing through a hybrid coupler which delivers equal amplitude

signals but is dephased of 90 degrees distinctly in two paths: one for the signal in phase with the incident signal, the other for the quadrature signal, and in that

- on the one hand, in the in-phase band, the signal passes through a linear amplifier prior to arriving at one of the inputs of a ring mixer, whose other input, after exiting a voltage-controlled oscillator, receives a signal in phase with the incident signal in such a way that the output of the ring mixer delivers a video signal which, after passing through a low-pass filter and an amplifier, constitutes the final video signal available at the output of the demodulator and;

- on the other hand, in the quadrature band, the signal is directed to a linear amplifier prior to arriving at one of the inputs of another ring mixer, whose other input, after the exiting the same controlled oscillator, receives - the same signal in phase with the incident signal but in quadrature with the signal with which it arrives at the mixer and in such a way that the output delivers a signal which, if the signal is output by the controlled oscillator and is perfectly in phase, has a null value and, if the signal is not perfectly in phase takes a positive or negative value as a function of the direction and the importance of the phase shift and generates an error signal which, after passing through a low-pass filet, an amplification chain, and a variable

capacitance diode, directs the controlled oscillator to cancel the error signal and, until the signal furnished by the controlled oscillator, will be perfectly in phase with the incident signal.

The invention will be better understood if reference is made to the description below and the non-limiting embodiment in the accompanying drawing, which is a schematic view of a synchronous demodulator in accordance with the invention:

Referring now to the drawing, the synchronous demodulator comprises a converter 1 whose reception frequency is an intermediate frequency, an amplifier 2 for this intermediate frequency, group propagation time corrector 3, and a sound demodulator 4, prior to a commutation block 5 facing the video demodulation circuits and envelope demodulator.

As soon as the intermediate frequency signal referred to as "incident signal" 6 penetrates the block 5, it passes through a relay control circuit 7 in order to be directed to either demodulation circuit 8 or 9.

In the synchronous circuit 8, this control circuit 7 may simultaneously ensure the function of attenuation 10 which allows to equalize the gains in both synchronous and envelope functions. Depending on the choice made be the user this control circuit 7 is, controlled by an inverter 11 placed in front, or by a remote control (not illustrated).

The envelope circuit 9 supplies a conventional demodulation circuit, while after possible attenuation, the synchronous circuit 8 sends a high frequency signal 12 to a hybrid coupler or to a delay line and through two channels signals 14, 15 of equal amplitude but dephased of ninety degrees.

In one of the channels, the signal 14 is in phase with the input signal 12; this is the demodulation channel. In the other channel, the signal 15 is dephased of ninety degrees relative to the input signal 12; this is the quadrature channel.

In the demodulation channel, signal 14 supplies an amplifier 16, whose linearity is very pronounced and which also offers a very wide bandwidth as well as an excellent stationary wave ratio in order to deliver a correct load to the coupler. However, the gain of the amplifier may be any value.

A signal 21, is now sent by this amplifier 16 and by means of an adaptation and control network 17 to one 18 of the inputs 18, 19 of a ring mixer 20. At this other input 19, this mixer 20 receives sufficiently high level second signal 22, which is delivered by a distribution network 23 at a level rendered sufficiently high by passing through an attenuator 24; this second signal 22 is measured at the output 25 of a voltage-controlled oscillator 26.

When the two signals 21 and 22 delivered in this manner to the mixer 20, are in phase, the output 27 of this mixer delivers a video signal 28 which, after passing through a low-pass filter 29, and by means of an amplifier 30, delivers the final video signal at one of a plurality of outputs 32, 33. and regardless of the level, remains controllable and, for example, one volt peak to peak.

In the quadrature channel, the signal 15 is directed to an amplifier 16' identical to 16 of the preceding channel. The signal 21' amplified in this manner is transmitted by a circuit 17' to one 18' of the inputs 18'-19' of another mixers 20'. By repeating the circuit diagram of the other channel, through a circuit 23' and passing an attenuator 24', this mixer 20' receives at its other input 19' the signal 22 from output 25 of the controlled oscillator 26 and in the same phase as the demodulation mixer 20.

From the hybrid coupler 13 to the low-pass filters 29-29', the two channels are strictly identical, both with respect to electric paths and with respect to the important criteria for different stages in order to maintain the quadrature relationship between the two high frequency signals 21-21' supplying mixers 20-20'. It is not until these two signals 21' and 21 or 22 are in quadrature, that the signal 28' processed in this manner has the property of being null. As a result, if the oscillator 26 drifts, the voltage

error signal 28', which itself is positive or negative as a function of the direction of the phase shift, maybe used through an amplification chain 34 of non-critical gain in order to control the oscillator 26 by means of a variable capacitance diode.

This quadrature channel, including the amplification chain 34 and the diode 35, thus form a phase-lock loop. It allows the error signal to be extracted without any processing the incident signal, and especially without the limiter or different correction devices otherwise necessary to eliminate the drawbacks associated with such a limiter. For example, this chain 34 will have an 80000 gain and will be arranged in such a way that if the oscillator 26 shifts are applied to the diode 35, the error voltage 28' in the appropriate direction for effecting in the oscillator 26 an inverse shift until the output voltage 28' of the quadrature mixer 20' will return to its null value and thus to the moment in which the oscillator 26 will be retuned to the locked in "phase" position.

In addition to this equilibrium position, the oscillator 26 would deregulate the demodulation channel and would have the effect of a static phase error on the useful video signal 31. One can see the importance of keeping identical electric paths in the two channels from the hybrid coupler 13 to the low pass filters 29-29' in order to preserve the 90° phase relation.

Any phase error, due, for example, to a thermal drift, is translated by the erroneous phase coherence between the incident signal 6 and that of the oscillator 26.

Since precise phase measurements have to be obtained, and a good transitory response has to be maintained, this error must not be allowed to exceed a certain value, for example, one degree, so that the amplitude of the output signal 31 of the in-phase mixer 20 is only slightly decreased.

Another consequence of an excessive error is the appearance at the output 27' of the quadrature mixer 20', i.e., at a location where it would normally not be present, of a video signal formed by an alternative signal 36 superimposed on a continuous signal 37.

The signal that appeared in this manner may be transmitted to an isolation amplifier 38, whose output signal 39 may be transmitted to a rear output 40, where it can be used for checking. For example, the signal 39 reaches more or less one volt peak to peak for a more or less 90° phase shift.

To keep the manufacturing price low, the isolation amplifier 38 may be part of the aforementioned chain 38.

Since the state of equilibrium is very important, utilization amplifier as calibration means for the static phase of the controlled oscillator 26 is very advantageous.

After the video signal 36 + 37 passes into a device 41, which is an obstacle to the passage of the continuous signal, the alternative signal 37 isolated in this manner, passes through a sensor 42 such as a voltage doubler, prior to arriving at a test oscillator 43.

The oscillator 43, scans by means of a variable capacitance diode 44, a certain range, for example, more or less 50 kilohertz relative to the initial line-up frequency.

This scanning allows the coincidence of the controlled oscillator frequency and that of the incident signal to be found; this is, of course, within the limits of which the incident signal is within the range scanned by the controlled oscillator 26.

At the moment of coincidence, the value of the error signal is zero, which is then utilized in order to stop the test oscillator 43.

A control device 45, arranged in the front, allows to apply voltage to a variable capacitance diode 46 which causes a shift in the controlled oscillator 26 with respect to the initial control frequency while completely keeping the range of the scanner under the control of the test oscillator 43. This shift primarily allows the synchronous demodulator to accommodate the shifted transmitters for reason of noise.

At rest, this also allows to transmit the frequency and phase coincidence of the controlled oscillator 26 together with the incident signal 6, which is an essential condition to ensure a correct static phase with a minimum of distortion in the transmitted signals.

More precise regulation may be ensured by observing the output voltage 39 available on the rear output 40. With all control and regulation voltages being centered on the protective ground, the potential read at this output 40 will be potential to ground when the controlled oscillator phase 26 and the incident signal 6 coincide.

The combination of signal 31 of one of the video outputs 32, 33 with the signal 39 transmitted by this rear output 40 in order to realize a "Lissajous" curve also allows the device to be controlled.

This allows primarily to verify that the static phase error is minimal and allows to display the conversion of the amplitude modulation /phase modulation.

The incident phase modulation, which may be caused by any stage in a controlled transmitter, can be controlled in the same manner.

In any case, with the energy of the carrier being utilized for fine control, it is never affected by variations in group propagation time.

In a variant for the embodiments, a phase inverter 47 is arranged in circuit 23' from the output 25 of the controlled oscillator to the synchronous mixer 20'.

This allows the demodulator to demodulate both the positive modulation signals, such as the ones in accordance with French standards, as well as the negative modulation signals in accordance with U.S. and German standards.

In fact, a simple operation of the inverter 47 allows a final video signal 31 of the same polarity to be obtained.

Other accessory means may, of course, be added, more particularly an automatic instant phase control device.

CLAIMS

1. Synchronous demodulator for the conversion of a television signal furnished by an transmitter into a video signal (31) especially for use in a measuring chain for the analysis of a signal furnished by said transmitter, said synchronous demodulator comprising at least one demodulation circuit (8) optionally equipped with a converter (1), to supply the same in order to convert the reception frequency into an intermediate frequency, an amplifier (2) for this intermediate frequency, an amplifier 2 for this intermediate frequency, group propagation time corrector 3, and a sound demodulator 4,

prior to a commutation block 5 comprising a commutation device (7) both toward the envelope demodulation circuit (9) or toward ?said synchronous demodulation circuit (8), with said demodulation circuit (8) being characterized in that, discharged ? from the commutation device (7) and without any limitation, the incident signal (12) is simply divided into two signals (14, 15) which remain at the same amplitude but which are dephased by 90° relative to one another and which take two distinct channels: one, for example for a signal (14) in phase with the incident signal (12), and the other for the two-phase signal (15) in quadrature with the former, and in that

- on the one hand, in the first in phase channel, the signal (14) passes through a linear amplifier (16) prior to arriving at one (18) of the inputs of a ring mixer (20) whose other input (19) receives from the output (25) of an voltage-controlled oscillator (26) a signal (22) which must be in phase with the signal of the first input (12) in such a way that the output (27) of the ring mixer delivers a video signal (28) which, after passing through a low-pass filet (29) and an amplifier (30) constitutes the final video (31) available at the output (32, 33) of the demodulator, and

- on the other hand, in the quadrature channel, the signal (15) is directed to linear amplifier (16') prior to arriving at one (18') of the inputs of another ring mixer (20') whose other input (19') receives from the output

(25) of the same controlled oscillator (26) the same signal (22) as the first mixer, but which, as a result, is in quadrature with the signal (21') with which the same arrives at the mixer (20') in such a way that the output (27') delivers a signal (28') which, when the signal output by the controlled oscillator is perfectly in phase is has a null value and which, when the signal (22) is not perfectly in phase, takes a positive or negative value relative to the direction and the significance of the phase shift and generates, as a result, an error signal (28') which, after passing through a low-pass filter (29'), an amplification chain (34), and a variable capacity diode (35) directs the controlled oscillator (26) to cancel the error signal (28') and, therefore, until the signal (22) furnished by the controlled oscillator 26 is perfectly in phase with the incident signal (12).

2. Synchronous demodulator as defined in Claim 1, characterized in that starting from means (13) to the low-pass filters (29-29'), the channels, the in-phase signal 14, and the quadrature signal 15 are strictly identical both, with respect to electrical paths as to important criteria for different stages.

3. Synchronous demodulator as defined in Claim 1 or 2, characterized in that , after passing through the low-pass filter (29') the error signal (28') is

transmitted to an isolation amplifier (38) whose output signal (39) is available at an output 40.

4. Synchronous demodulator as defined in one of Claims 1 to 3, characterized in that after passing though the low-pass filter (29') and isolation amplifier (38), the error signal (28') formed by a continuous signal (36) supposed on an alternative signal (37) is transmitted to a device (41) which is an obstacle to the passage of the continuous signal (36) in order for the alternative signal (37) being isolated in this manner to be able pass though a sensor (42) prior to arriving at a test oscillator (43) which, by means of a variable capacity diode (44) scans to the control oscillator a certain range of frequencies on both sides of the initial control frequency.

5. Synchronous demodulator as defined in one of Claims 1 to 4, characterized in that said demodulator comprises, preferably in the front, a control device (45) which allows to apply to a variable capacity diode (46) a frequency that causes a shift in the controlled oscillator (26) relative to the initial regulation frequency.

6. Synchronous demodulator as defined in one of Claims 1 to 5, characterized in that, on the circuit (23) going from the output (25) of the controlled oscillator (26) to the quadrature mixer (20'), a phase inverter (47) is interposed.

7. Synchronous demodulator as defined in one of Claims 1 to 6, characterized in that on each of the circuits (23-23') starting from the output (25) of the controlled oscillator (26) to the synchronous mixers (20) and quadrature mixers (20') an attenuator (24-24') is interposed.

8. Synchronous demodulator as defined in one of Claims 1 to 7, characterized in that the means (13) for splitting the incident signals into two dephased signals into 90°, is a hybrid coupler.

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